

REMARKS

Reconsideration and allowance are respectfully requested.

Claims 1, 4-9, 12-13, 15, 18-24 and 30-32 are pending. Claims 19-20, 22 and 24 were withdrawn from consideration by the Examiner. Rejoinder of the withdrawn claims is requested upon allowance of a generic claim.

Claims 1, 4-9, 12-13, 15, 18, 21, 23 and 30-32 are now rejected under Section 103(a) as allegedly unpatentable over Shastri et al. (U.S. Application 2007/0026069). Applicant traverses. This new rejection was made final. Since Applicant lacks the opportunity to submit an IDS after a final rejection, the Examiner's cooperation is requested to make of record the attached three research papers: Pek et al. (Nature Biotechnol., vol. 3, pp. 671-675, 2008), Seo et al. (Polymer Int'l, vol. 57, pp. 1101-1109, 2008), and Ansarifar et al. (Rubber Chem. Technol., vol. 76, pp. 1290-1310, 2003). They could not be submitted earlier because this new rejection was the first time that Shastri was cited by the Examiner. Therefore, Applicant's initial opportunity to rebut the allegations in the final Office Action is in the present response.

A claimed invention is unpatentable if the differences between it and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art. *In re Kahn*, 78 USPQ2d 1329, 1334 (Fed. Cir. 2006) citing the legal standard provided in *Graham v. John Deere*, 148 USPQ 459 (1966). The *Graham* analysis needs to be made explicitly. *KSR v. Teleflex*, 82 USPQ2d 1385, 1396 (2007). It requires findings of fact and a rational basis for combining the prior art disclosures to produce the claimed invention. See *id.* ("Often, it will be necessary for a court to look to interrelated teachings of multiple patents . . . and the background knowledge possessed by a person having ordinary skill in the art, all in order to determine whether there was an apparent reason to combine the known elements in the fashion claimed by the patent at issue"). The use of hindsight reasoning is impermissible. See *id.* at 1397 ("A factfinder should be aware, of course, of the distortion caused by hindsight bias and must be cautious of arguments reliant upon *ex post* reasoning"). Thus, a *prima facie* case of obviousness requires "some rationale, articulation, or reasoned basis to explain why the conclusion of obviousness is correct." *Kahn*,

78 USPQ2d at 1335; see *KSR*, 82 USPQ2d at 1396. A claim which is directed to a combination of prior art elements “is not proved obvious merely by demonstrating that each of its elements was, independently, known in the prior art.” *Id.* at 1396. Finally, a determination of *prima facie* obviousness requires a reasonable expectation of success. See *In re Rinehart*, 189 USPQ 143, 148 (C.C.P.A. 1976).

Applicant’s claimed invention is directed to three-dimensionally networked silica that can be used in articles of manufacture (e.g., as an additive to rubber compounds). To achieve the advantages of his invention, the amount of silica particles added to the article, their size, and the bridge chains connecting them for Applicant’s product distinguish over the prior art.

Although both Applicant and Shastri describe their products as 3-dimensional, and further use aminopropyltriethoxy silane and polyethylene glycol as modifying reagents, the claimed invention and Shastri’s product are not prepared in the same manner, they thus have different functions, and they also differ in their applications.

Shastri discloses an invention related to cell culture. The solid particles, which include silica, are used to enhance the efficiency of culture and contact of biological tissue to polymeric materials. For example, the attached research paper of Pek et al. (*Nature Biotechnol.* 3:671-675, 2008) shows the same type of material.

Shastri described technology for the effective incorporation of polymeric materials on biological tissues by dispersing or shaping them on solid particles. Various solid particles such as TiO_2 , ZrO_2 , Y_2O_3 , and SiO_2 and various polymeric matrices such as alginate, hyaluronic acid, polyethylene glycol, polyvinyl alcohol, and collagen were employed for culture thereon of cells, tissue, bone, and skeleton. The cited document requires polymers of large molecular weight to form a three-dimensional construct on the solid particles. Although the three-dimensional construct is comprised of solid particles and polymer matrix, the particles themselves do not form a three-dimensional structure. Instead they are surface modified; they are not connected to each other with bridging chains. But it is the polymeric matrix, which is formed on the particles, that provides the three-dimensional structure of the construct. See paragraph [0056] of Shastri.

As a consequence, all interaction (e.g., covalent bonding, hydrogen bonding, ionic bonding, and even van der Waals force), regardless of their type, can be used to combine polymeric materials with solid particles. See paragraph [0042] of Shastri. In Shastri's three-dimensional construct, solid particles were never connected to each other. See Fig. 1 of Shastri. They act only as supports for the polymeric matrix making a three-dimensional construct to combine with biological tissues as shown in Pek's Fig. 1.

The polymeric materials were combined with solid particles through two steps: first, solid particles were modified with silane having an amino functional group and, second, polymeric materials on the solid particles were accumulated to form monolayers and multilayers. At the second step, poly(acrylic acid) and collagen with large molecular weights were employed to improve their affinity for biological tissues. Typical of Shastri, a procedure is described to prepare a composite composed of poly(lactic acid) and silica particles, which were functionalized previously with silane and treated further with biopolymers such as hydroxyapatite and collagen on them.

In contrast, Applicant's invention describes technology to connect silica particles with bridge chains to form a three-dimensional network. The fundamental concept of our invention was to connect silica particles to form a networked structure, even though it also used 3-aminopropyltriethoxy silane as a modifying reagent. In addition, various chemicals such as silane and diisocyanates were used to form a network among silica particles. Rubber molecules compounded with silica particles in networked structures entangled with the connecting chains, resulting in improved tensile properties for Applicant's claimed network without an excessive increase in its modulus. Use of networked silica as a reinforcing material for the rubber compound does not require any coupling reagents which usually have ethoxy groups to be combined with silica. This omission eliminates the production of ethanol. And no formation of ethanol at the cure of rubber compounds reduces processing time or the need to remove ethanol because it causes serious failure of tires when they are run. A low increase in modulus of the rubber compounds reinforced with networked silica makes it possible to increase silica content to improve fuel efficiency of tires. Therefore, Applicant's invention was simply to focus on a method to produce an effective network of silica particles, resulting in high reinforce-

cing performance in rubber compounds, instead of modifying the surface of silica particles. Surface modification using polyethylene glycol was an additional treatment to reduce the viscosity of rubber compounds. Since the use of networks to improve the reinforcing performance of silica was considered novel and nonobvious, our research paper describing the networked silica was published as Seo et al. (Polymer Int'l 57:1101-1109, 2008).

Shastri's objective was to prepare three-dimensional constructs of polymeric materials to combine readily with biological materials and solid particles. But Applicant described connecting silica particles with bridge chains in order to enhance the tensile property of rubber compounds by intruding rubber molecules into the voids of networked silica and entangling rubber molecules with the connecting chains. Three-dimensionally networked silica particles improve the physical properties of rubber compounds, especially their tensile property which is an important factor in determining the durability and safety of tires.

Two kinds of chemicals were generally employed by Shastri to produce three-dimensional constructs. The first chemical modified the surface of the particle (i.e., 3-aminopropyltriethoxy silane) and the second chemical was generally high molecular weight polymer. By contrast, Applicant's product employs various materials with functional groups including an amino group, glycidoxyl group, isocyanate groups, etc. as connecting chains. Silanes with epoxy and chloride groups were also effective to form three-dimensional networks among silica particles. Diisocyanate was also used.

Differences between Applicant's product and Shastri's product may be seen from their processes of manufacture. The molecular weights of the bridging chains used by Applicant were significantly different from those used by Shastri. Large polymeric materials with high molecular weight were employed by Shastri to form three-dimensional constructs of the polymeric materials on solid particles, but small molecules with low molecular weights were employed by Applicant to connect silica particles. Polymeric materials themselves formed a three-dimensional shape that could show good contact on biological materials, while no polymeric materials with large molecular weights was used in the preparation of Applicant's networked silica. The molecular weight of poly-

ethylene glycol used as a surface modifier in the preparation of the networked silica ranged only from 200 to 1,000.

Shastri claimed various solid particles as supports for polymeric materials: TiO_2 , ZrO_2 , Y_2O_3 , and SiO_2 . The role of solid particles in Shastri was as a mass center of polymeric materials, and thus, their chemical properties were not important. Any solid particle could be used if they were modified with silane to combine with organic materials. Only silica, however, was effective in Applicant's product as a reinforcing filler in rubber compounds. These differences clearly demonstrated that Applicant's claimed networked silica distinguished over Shastri's product.

The amount of solid particles dispersed in the polymeric materials depended on their purpose. In Shastri, solid particles were a mass center supporting polymeric materials to form a three-dimensional structure. Thus, only a small amount of solid particles was required. Therefore, Shastri claimed that the lower limit for the added amount of solid particles was 0.01 vol%. On the contrary, the networked silica produced in Applicant's specification contained a large amount of silica: around 90 wt%. Applicant's silica particles were connected by bridge chains. They interacted with rubber molecules and reinforced the rubber molecules by entanglement. Therefore, the amount of silica used for the production of Applicant's networked silica was much more than that in the three-dimensional constructs described in Shastri. The difference in the added amount of silica between Applicant and Shastri was caused by the role of silica in their products: the connection among silica particles was essential in Applicant's product while solid particles (e.g., silica) did not directly contact biological tissues in Shastri's product, wherein the solid particles worked as only a mass center to hold polymeric materials thereon.

The size of solid particles was not important to Shastri, so their size ranged very widely from 10 nm to 5,000 nm. Slightly large solid particles were preferred because they could support polymeric materials on them. As shown in Figs. 2 and 4 of Shastri, silica particles with diameters of around 500 nm were employed to prepare the three-dimensional constructs. But the particle size of Applicant's silica determined its reinforcing performance with rubber compounds. Cf. claim 30. Since silica particles could

interact with rubber molecules, their particle sizes were small to increase their external surface area. As a consequence, the size of silica particles used as a reinforcing filler was limited in the range of 10-100 nm. More generally, silica particles less than 50 nm were preferably used as a reinforcing filler. See Ansarifar et al. (Rubber Chem. Technol. 76:1290-1310, 2003). Actually, silica particles larger than 100 nm did not show any reinforcing performance in Shastri. This difference in size of solid particles between Applicant's product and Shastri's product strongly supports the conclusion that their operating principles are not the same.

Polymeric materials with three-dimensional shape covered the external surface of solid particles as shown in Shastri's Fig. 1. They had three-dimensional shape, but the solid particles did not confer any definite structure on Shastri's product. The silica particles, however, were connected by bridge chains in Applicant's claimed invention as shown in Fig. 1 of the present specification. Silica particles formed a three-dimensional network in Applicant's claimed invention, while it was the polymeric material made the three-dimensional construct of Shastri's product.

Polymeric materials coated on Shastri's solid particles combined with various biological tissues such as cell, tissue, bone, and skeleton. It related to improving the connection between polymeric materials and biological tissue. In contrast, Applicant's product formed a three-dimensional network of silica particles to enhance the tensile property of rubber compounds. The three-dimensional network formed among silica particles enhanced the filler-rubber interaction between rubber molecules and highly dispersed silica particles, and the entanglement of rubber molecules with the connecting chains of networked silica. Therefore, the three-dimensional constructs prepared by following Shastri's disclosure provided a scaffold for biological tissue in tissue, but Applicant's claimed networked silica can be added to rubber such as styrene-butadiene rubber and natural rubber. The clear differences in their uses reflect the difference in the role of solid particles in the two products, and ultimately the differences in structure between Applicant's product and Shastri's product.

Since Shastri presented an effective way for the surface modification of solid particles by polymeric materials, its disclosure can be readily expanded to wool, glass,

ceramics, and wood. Shastri's claims also covered the modification of the surface which was able to be connected. On the contrary, Applicant's disclosure focused strictly on rubber compounds that can be effectively reinforced by networked silica. The claimed invention of the present application did not try to expand its claims to surface modification since the main interest of Applicant was to strengthen rubber compounds.

Applicant submits that the features of the claimed invention discussed above are sufficient to distinguish over Shastri so any other incorrect allegations about the cited disclosure are not disputed here, but the opportunity to dispute them in the future is reserved. Shastri does not render obvious the claimed invention because one of ordinary skill in the art would not have had a reason to make the changes necessary to modify its disclosure and or a reasonable expectation of success to reproduce the claimed invention by such changes.

Therefore, withdrawal of the Section 103 rejection is requested because Applicant's claims are not obvious over Shastri.

Having fully responded to the pending Office Action, Applicant submits that the claims are in condition for allowance and earnestly solicit an early Notice to that effect. The Examiner is invited to contact the undersigned if any further information is required.

Respectfully submitted,

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